Claims

1. A detector for use in a mass spectrometer, said detector comprising:

a microchannel plate, wherein in use particles are received at an input surface of said microchannel plate and electrons are released from an output surface of said microchannel plate, said output surface having a first area; and

a detecting device having a detecting surface arranged to receive in use at least some of the electrons released from said microchannel plate, said detecting surface having a second area;

wherein said second area is substantially greater than said first area.

2. A detector as claimed in claim 1, wherein said second area is at least 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% greater than said first area.

3. A detector as claimed in claim 1, wherein said second area is at least 150%, 200%, 250%, 300%, 350%, 400%, 450% or 500% greater than said first area.

4. A detector for use in a mass spectrometer, said detector comprising:

a microchannel plate, wherein in use particles are received at an input surface of said microchannel plate and electrons are released from an output surface of

said microchannel plate, wherein on average x electrons per unit area are released from said output surface; and

a detecting device having a detecting surface arranged to receive in use at least some of the electrons generated by said microchannel plate, wherein on average y electrons per unit area are received on said detecting surface;

wherein x > y.

5. A detector as claimed in claim 4, wherein x is at least 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% greater than y.

6. A detector as claimed in claim 4, wherein x is at least 150%, 200%, 250%, 300%, 350%, 400%, 450% or 500% greater than said first area.

7. A detector as claimed in any claim 1, wherein said particles comprise ions.

8. A detector as claimed in any of claims 1, wherein said particles comprise photons or electrons.

9. A detector as claimed in claim 1, wherein in use electrons released from said output surface of said microchannel plate are released into a region having an electric field.

10. A detector as claimed in claim 9, further comprising one or more electrodes arranged such that an

electric field is provided between said microchannel plate and said detecting device.

11. A detector as claimed in claim 10, wherein said one or more electrodes comprises one or more annular electrodes.

12. A detector as claimed in claim 10, wherein said one or more electrodes comprises one or more Einzel lens arrangements comprising three or more electrodes.

13. A detector as claimed in claim 10, wherein said one or more electrodes comprises one or more segmented rod sets.

14. A detector as claimed in claim 10, wherein said one or more electrodes comprises one or more tubular electrodes.

15. A detector as claimed in claim 10, wherein said one or more electrodes comprises one or more quadrupole, hexapole, octapole or higher order rod sets.

16. A detector as claimed in claim 10, wherein said one or more electrodes comprises a plurality of electrodes having apertures through which electrons are transmitted in use, said apertures having substantially the same area.

17. A detector as claimed in claim 10, wherein said one or more electrodes comprises a plurality of electrodes having apertures through which electrons are transmitted

in use, said apertures becoming progressively smaller or larger in a direction towards said detecting device.

18. A detector as claimed in claim 1, wherein in use said output surface of said microchannel plate is maintained at a first potential and said detecting surface of said detecting device is maintained at a second potential.

19. A detector as claimed in claim 18, wherein said second potential is more positive than said first potential.

20. A detector as claimed in claim 19, wherein the potential difference between said surface of said detecting device and said output surface of said microchannel plate is selected from the group consisting of: (i) 0-50 V; (ii) 50-100 V; (iii) 100-150 V; (iv) 150-200 V; (v) 200-250 V; (vi) 250-300 V; (vii) 300-350 V; (viii) 350-400 V; (ix) 400-450 V; (x) 450-500 V; (xi) 500-550 V; (xii) 550-600 V; (xiii) 600-650 V; (xiv) 650-700 V; (xv) 700-750 V; (xvi) 750-800 V; (xvii) 800-850 V; (xviii) 850-900 V; (xix) 900-950 V; (xx) 950-1000 V; (xxi) 1.0-1.5 kV; (xxii) 1.5-2.0 kV; (xxiii) 2.0-2.5 kV; (xxiv) > 2.5 kV; and (xxv) < 10 kV.

21. A detector as claimed in claim 9, wherein in use said output surface of said microchannel plate is maintained at a first potential, said detecting surface of said detecting device is maintained at a second potential and one or more electrodes disposed between

said microchannel plate and said detecting surface are maintained at a third potential.

22. A detector as claimed in claim 21, wherein in use one or more electrodes disposed between said microchannel plate and said detecting surface are maintained at a fourth potential.

23. A detector as claimed in claim 22, wherein in use one or more electrodes disposed between said microchannel plate and said detecting surface are maintained at a fifth potential.

24. A detector as claimed in claim 23, wherein said third and/or fourth and/or fifth potential is substantially equal to said first and/or second potential.

25. A detector as claimed in claim 23, wherein said third and/or fourth and/or fifth potential is more positive than said first and/or second potential.

26. A detector as claimed in claim 23, wherein said third and/or fourth and/or fifth potential is more negative than said first and/or second potential.

27. A detector as claimed in claim 23, wherein the potential difference between said third and/or fourth and/or fifth potential and said first and/or said second potential is selected from the group consisting of: (i) 0-50 V; (ii) 50-100 V; (iii) 100-150 V; (iv) 150-200 V; (v) 200-250 V; (vi) 250-300 V; (vii) 300-350 V; (viii)

350-400 V; (ix) 400-450 V; (x) 450-500 V; (xi) 500-550 V; (xii) 550-600 V; (xiii) 600-650 V; (xiv) 650-700 V; (xv) 700-750 V; (xvi) 750-800 V; (xvii) 800-850 V; (xviii) 850-900 V; (xix) 900-950 V; (xx) 950-1000 V; (xxi) 1.0-1.5 kV; (xxii) 1.5-2.0 kV; (xxiii) 2.0-2.5 kV; (xxiv) > 2.5 kV; and (xxv) < 10 kV.

28. A detector as claimed in claim 23, wherein said third and/or fourth and/or fifth potential is intermediate said first and/or said second potentials.

29. A detector as claimed in claim 1, further comprising a grid electrode arranged between said microchannel plate and said detecting device.

30. A detector as claimed in claim 29, wherein said grid electrode is substantially hemispherical or otherwise non-planar.

31. A detector as claimed in claim 1, wherein said detecting device comprises a single detecting region.

32. A detector as claimed in claim 31, wherein said single detecting region comprises: (i) an electron multiplier; (ii) a scintillator; or (iii) a photo-multiplier tube.

33. A detector as claimed in claim 32, wherein said single detecting region comprises one or more microchannel plates.

34. A detector as claimed in claim 33, wherein said one or more microchannel plates receives in use over a first number of channels at least some electrons released from a second number of channels of said microchannel plate arranged upstream of said detecting device, wherein said first number of channels is substantially greater than said second number of channels.

35. A detector as claimed in claim 1, wherein said detecting device comprises a first detecting region and at least a second separate detecting region.

36. A detector as claimed in claim 35, wherein said second detecting region is spaced apart from said first detecting region.

37. A detector as claimed in claim 35, wherein said first and second detecting regions have substantially equal detecting areas.

38. A detector as claimed in claim 35, wherein said first and second detecting regions have substantially different detecting areas.

39. A detector as claimed in claim 38, wherein the area of said first detecting region is greater than the area of said second detecting region by a percentage p, wherein p is selected from the group consisting of: (i) < 10%; (ii) 10-20%; (iii) 20-30%; (iv) 30-40%; (v) 40-50%; (vi) 50-60%; (vii) 60-70%; (viii) 70-80%; (xi) 80-90%; and (x) > 90%.

40. A detector as claimed in claim 35, wherein in use the number of electrons received by said first detecting area is greater than the number of electrons received by said second detecting area by a percentage q, wherein q is selected from the group consisting of: (i) < 10%; (ii) 10-20%; (iii) 20-30%; (iv) 30-40%; (v) 40-50%; (vi) 50-60%; (vii) 60-70%; (viii) 70-80%; (xi) 80-90%; and (x) > 90%.

41. A detector as claimed in claim 35, further comprising at least one electrode arranged so that in use at least some electrons released from said microchannel plate are guided to said first detecting region and/or at least some electrons released from said microchannel plate are guided to said second detecting region.

42. A detector as claimed in claim 35, wherein said first detecting region comprises: (i) one or more microchannel plates; (ii) an electron multiplier; (iii) a scintillator; or (iv) a photo-multiplier tube.

43. A detector as claimed in claim 35, wherein said second detecting region comprises: (i) one or more microchannel plates; (ii) an electron multiplier; (iii) a scintillator; or (iv) a photo-multiplier tube.

44. A detector as claimed in claim 1, wherein said detecting device comprises at least one chevron pair of microchannel plates.

45. A detector as claimed in claim 1, further comprising at least one collector plate arranged to receive in use at least some electrons generated and released by said detecting device.

46. A detector as claimed in claim 45, wherein said at least one collector plate is shaped to at least partially compensate for a temporal spread in the flight time of electrons incident on said detecting device.

47. A detector as claimed in claim 1, wherein said detecting device is shaped to at least partially compensate for a temporal spread in the flight time of electrons incident on said detecting device.

48. A detector as claimed in claim 1, further comprising one or more electrodes arranged so as to at least partially compensate for a temporal spread in the flight time of electrons incident on said detecting device.

49. A detector for use in a mass spectrometer, said detector comprising:

a microchannel plate, wherein in use particles are received at an input surface of said microchannel plate and electrons are released from an output surface of said microchannel plate, said output surface having a first area;

a detecting device having a detecting surface having a second area;

a first device arranged between said microchannel plate and said detecting device, said first device being

arranged to receive at least some of said electrons released from said output surface of said microchannel plate and to generate photons; and

a second device arranged between said first device and said detecting device, said second device arranged to receive at least some of said photons generated by said first device and to release electrons;

wherein said detecting surface is arranged to receive at least some of the electrons generated by said second device; and

wherein said second area is substantially greater than said first area.

50. A detector as claimed in claim 49, wherein said second area is at least 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% greater than said first area.

51. A detector as claimed in claim 49, wherein said second area is at least 150%, 200%, 250%, 300%, 350%, 400%, 450% or 500% greater than said first area.

52. A detector for use in a mass spectrometer, said detector comprising:

a microchannel plate, wherein in use particles are received at an input surface of said microchannel plate and electrons are released from an output surface of said microchannel plate, wherein on average x electrons per unit area are released from said output surface;

a detecting device having a detecting surface having a second area;

a first device arranged between said microchannel plate and said detecting device, said first device being arranged to receive at least some of said electrons released from said output surface and to generate photons; and

a second device arranged between said first device and said detecting device, said second device arranged to receive at least some of said photons generated by said first device and to release electrons;

wherein said detecting surface is arranged to receive at least some of the electrons generated by said second device, said detecting surface receiving on average y electrons per unit area; and

wherein x > y.

53. A detector as claimed in claim 52, wherein x is at least 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% greater than y.

54. A detector as claimed in claim 52, wherein x is at least 150%, 200%, 250%, 300%, 350%, 400%, 450% or 500% greater than y.

55. A detector for use in a mass spectrometer, said detector comprising:

a microchannel plate, wherein in use particles are received at an input surface of said microchannel plate and electrons are released from an output surface of said microchannel plate, said output surface having a first area;

a detecting device having a detecting surface

having a second area; and

a first device arranged between said microchannel plate and said detecting device, said first device being arranged to receive at least some of said electrons released from said output surface of said microchannel plate and to generate photons;

wherein said detecting surface is arranged to receive at least some of said photons generated by said first device; and

wherein said second area is substantially greater than said first area.

56. A detector as claimed in claim 55, wherein said second area is at least 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% greater than said first area.

57. A detector as claimed in claim 55, wherein said second area is at least 150%, 200%, 250%, 300%, 350%, 400%, 450% or 500% greater than said first area.

58. A detector for use in a mass spectrometer, said detector comprising:

a microchannel plate, wherein in use particles are received at an input surface of said microchannel plate and electrons are released from an output surface of said microchannel plate, wherein on average x electrons per unit area are released from said output surface;

a detecting device; and

a first device arranged between said microchannel plate and said detecting device, said first device arranged to receive at least some of said electrons

released from said output surface of said microchannel plate and to generate photons;

wherein said detecting device is arranged to receive at least some of the photons generated by said first device, said detecting device receiving on average z photons per unit area; and

wherein x > z.

59. A detector as claimed in claim 58, wherein x is at least 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% greater than z.

60. A detector as claimed in claim 58, wherein x is at least 150%, 200%, 250%, 300%, 350%, 400%, 450% or 500% greater than z.

61. A detector as claimed in claim 55, wherein said photons are UV photons.

62. A mass spectrometer comprising a detector as claimed in claim 1.

63. A mass spectrometer as claimed in claim 62, wherein said detector forms part of a Time of Flight mass analyser.

64. A mass spectrometer as claimed in claim 62, further comprising an Analogue to Digital Converter ("ADC") connected to said detector.

65. A mass spectrometer as claimed in claim 62, further comprising a Time to Digital Converter ("TDC") connected to said detector.

66. A mass spectrometer as claimed in claim 62, further comprising an ion source selected from the group consisting of: (i) an Electrospray Ionisation ("ESI") ion source; (ii) an Atmospheric Pressure Ionisation ("API") ion source; (iii) an Atmospheric Pressure Chemical Ionisation ("APCI") ion source; (iv) an Atmospheric Pressure Photo Ionisation ("APPI") ion source; (v) a Laser Desorption Ionisation ("LDI") ion source; (vi) an Inductively Coupled Plasma ("ICP") ion source; (vii) a Fast Atom Bombardment ("FAB") ion source; (viii) a Liquid Secondary Ion Mass Spectrometry ("LSIMS") ion source; (ix) a Field Ionisation ("FI") ion source; (x) a Field Desorption ("FD") ion source; (xi) an Electron Impact ("EI") ion source; (xii) a Chemical Ionisation ("CI") ion source; and (xiii) a Matrix Assisted Laser Desorption Ionisation ("MALDI") ion source.

67. A mass spectrometer as claimed in claim 66, wherein said ion source is continuous or pulsed.

68. A method of detecting particles comprising:

receiving particles at an input surface of a microchannel plate;

releasing electrons from an output surface of said microchannel plate, said output surface having a first area; and

receiving at least some of said electrons on a detecting surface of a detecting device, said detecting surface having a second area;

wherein said second area is substantially greater than said first area.

69. A method as claimed in claim 68, wherein said second area is at least 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% greater than said first area.

70. A method as claimed in claim 68, wherein said second area is at least 150%, 200%, 250%, 300%, 350%, 400%, 450% or 500% greater than said first area.

71. A method of detecting particles comprising:

receiving particles at an input surface of a microchannel plate;

releasing on average x electrons per unit area from an output surface of said microchannel plate;

receiving at least some of said electrons on a detecting surface of a detecting device, wherein said detecting surface receives on average y electrons per unit area;

wherein x > y.

72. A method as claimed in claim 71, wherein x is at least 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% greater than y.

73. A method as claimed in claim 71, wherein x is at least 150%, 200%, 250%, 300%, 350%, 400%, 450% or 500% greater than y.

74. A method of detecting particles comprising:

receiving particles at an input surface of a microchannel plate;

releasing electrons from an output surface of said microchannel plate, said output surface having a first area;

receiving at least some of said electrons on a first device, said first device generating photons in response thereto;

receiving at least some of said photons on a second device, said second device generating and releasing electrons in response thereto; and

receiving at least some of the electrons generated by said second device on a detecting device having a detecting surface having a second area;

wherein said second area is greater than said first area.

75. A method as claimed in claim 74, wherein said second area is at least 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% greater than said first area.

76. A method as claimed in claim 74, wherein said second area is at least 150%, 200%, 250%, 300%, 350%, 400%, 450% or 500% greater than said first area.

77. A method of detecting particles comprising;

receiving particles at an input surface of a microchannel plate;

releasing on average x electrons per unit area from an output surface of said microchannel plate;

receiving at least some of said electrons on a first device, said first device generating photons in response thereto;

receiving at least some of said photons on a second device, said second device generating and releasing electrons in response thereto; and

receiving at least some of the electrons generated by said second device on a detecting surface of a detecting device, said detecting surface receiving on average y electrons per unit area;

wherein x > y.

78. A method as claimed in claim 77, wherein x is at least 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% greater than y.

79. A method as claimed in claim 77, wherein x is at least 150%, 200%, 250%, 300%, 350%, 400%, 450% or 500% greater than y.

80. A method of detecting particles comprising;

receiving particles at an input surface of a microchannel plate;

releasing electrons from an output surface of said microchannel plate, said output surface having a first area;

receiving at least some of said electrons on a device, said device generating photons in response thereto;

receiving at least some of said photons generated by said device on a detecting surface of a detecting device having a second area;

wherein said second area is substantially greater than said first area.

81. A method as claimed in claim 80, wherein said second area is at least 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% greater than said first area.

82. A method as claimed in claim 80, wherein said second area is at least 150%, 200%, 250%, 300%, 350%, 400%, 450% or 500% greater than said first area.

83. A method of detecting particles comprising;

receiving particles at an input surface of a microchannel plate;

releasing on average x electrons per unit area from an output surface of said microchannel plate;

receiving at least some of said electrons on a device, said device generating photons in response thereto;

receiving at least some of the photons generated by said device on a detecting surface of a detecting device, said detecting surface receiving on average z photons per unit area;

wherein $x > z$.

84. A method as claimed in claim 83, wherein x is at least 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% greater than z.

85. A method as claimed in claim 83, wherein x is at least 150%, 200%, 250%, 300%, 350%, 400%, 450% or 500% greater than z.

86. A method of mass spectrometry comprising a method of detecting particles as claimed in claim 68.